

## WHAT IS CLAIMED IS:

1. A synthetic polynucleotide comprising a DNA sequence encoding a nonmammalian protein or fragment thereof, the DNA sequence comprising codons optimized for expression in a mammalian host.
  2. The polynucleotide of Claim 1 wherein the protein is selected from HIV proteins, HSV proteins, HAV proteins, HBV proteins, HCV proteins, HPV proteins, Plasmodium proteins, Mycobacterium proteins, Borrelia proteins and rotavirus proteins.
  3. The polynucleotide of Claim 2 wherein the protein is an HIV protein.
  4. The polynucleotide of Claim 3 having the following DNA sequence:
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1  AGATCTACCA TGGGTGCTAG GGCTTCTGTG CTGTCTGGTG GTGAGCTGGA
51 CAAGTGGGAG AAGATCAGGC TGAGGCCTGG TGGCAAGAAG AAGTACAAGC
101 TAAAGCACAT TGTGTGGGCC TCCAGGGAGC TGGAGAGGTT TGCTGTGAAC
151 CCTGGCCTGC TGGAGACCTC TGAGGGGTGC AGGCAGATCC TGGGCCAGCT
201 CCAGCCCTCC CTGCAAACAG GCTCTGAGGA GCTGAGGTCC CTGTACAACA
251 CAGTGGCTAC CCTGTACTGT GTGCACCAGA AGATTGATGT GAAGGACACC
301 AAGGAGGCCC TGGAGAAGAT TGAGGAGGAG CAGAACAAGT CCAAGAAGAA
351 GGCCCAGCAG GCTGCTGCTG GCACAGGCAA CTCCAGCCAG GTGTCCCAGA
401 ACTACCCCAT TGTGCAGAAC CTCCAGGGCC AGATGGTGCA CCAGGCCATC
451 TCCCCCGGA CCCTGAATGC CTGGGTGAAG GTGGTGGAGG AGAAGGCCTT
501 CTCCCCTGAG GTGATCCCCA TGTTCTCTGC CCTGTCTGAG GGTGCCACCC
551 CCCAGGACCT GAACACCATG CTGAACACAG TGGGGGGCCA TCAGGCTGCC
601 ATGCAGATGC TGAAGGAGAC CATCAATGAG GAGGCTGCTG AGTGGGACAG
651 GCTGCATCCT GTGCACGCTG GCCCCATTGC CCCC GGCCAG ATGAGGGAGC
701 CCAGGGGCTC TGACATTGCT GGCACCACCT CCACCCTCCA GGAGCAGATT
751 GGCTGGATGA CCAACAACCC CCCCATCCCT GTGGGGGAAA TCTACAAGAG

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801 GTGGATCATC CTGGGCCTGA ACAAGATTGT GAGGATGTAC TCCCCCACCT  
 5 851 CCATCCTGGA CATCAGGCAG GGGCCCAAGG AGCCCTTCAG GGACTATGTG  
 901 GACAGGTTCT ACAAGACCCT GAGGGCTGAG CAGGCCTCCC AGGAGGTGAA  
 951 GAACTGGATG ACAGAGACCC TGCTGGTGCA GAATGCCAAC CCTGACTGCA  
 10 1001 AGACCATCCT GAAGGCCCTG GGGCCTGCTG CCACCCTGGA GGAGATGATG  
 1051 ACAGCCTGCC AGGGGGTGGG GGGCCCTGGT CACAAGGCCA GGGTGCTGGC  
 1101 TGAGGCCATG TCCCAGGTGA CCAACTCCGC CACCATCATG ATGCAGAGGG  
 15 1151 GCAACTTCAG GAACCAGAGG AAGACAGTGA AGTGCTTCAA CTGTGGCAAG  
 1201 GTGGGCCACA TTGCCAAGAA CTGTAGGGCC CCCAGGAAGA AGGGCTGCTG  
 20 1251 GAAGTGTGGC AAGGAGGGCC ACCAGATGAA GGACTGCAAT GAGAGGCAGG  
 1301 CCAACTTCCT GGGCAAAATC TGGCCCTCCC ACAAGGGCAG GCCTGGCAAC  
 1351 TTCCTCCAGT CCAGGCCTGA GCCCAGAGCC CCTCCCGAGG AGTCCTTCAG  
 25 1401 GTTTGGGGAG GAGAAGACCA CCCCCAGCCA GAAGCAGGAG CCCATTGACA  
 1451 AGGAGCTGTA CCCCCTGGCC TCCCTGAGGT CCCTGTTTGG CAACGACCCC  
 30 1501 TCCTCCCACT AAAATAAAGC CCGGCAGAT CT  
 (SEQ ID NO:1).

5. The polynucleotide of Claim 3 which induces anti-  
 HIV neutralizing antibody, HIV specific T-cell immune responses, or  
 35 protective immune responses upon introduction into vertebrate tissue,  
 including human tissue *in vivo*, wherein the polynucleotide comprises a  
 gene encoding an HIV *gag*, *gag*-protease, or *env* gene product,

6. A method for inducing immune responses in a  
 40 vertebrate which comprises introducing between 1 ng and 100 mg of the  
 polynucleotide of Claim 1 into the tissue of the vertebrate.

7. The method of Claim 6 which further comprises  
 administration of attenuated pathogen, killed pathogen, subunit  
 45 vaccines, protein vaccines and combinations thereof.

8. An immunogenic composition for inducing immune responses against HIV infection which comprises the polynucleotide of Claim 3 and a pharmaceutically acceptable carrier, and optionally, an adjuvant.

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9. A method for inducing anti-HIV immune responses in a primate which comprises introducing the polynucleotide of Claim 3 into the tissue of said primate and concurrently administering a cytokine parenterally.

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10. A method of inducing an antigen presenting cell to stimulate cytotoxic and helper T-cell proliferation and effector functions including lymphokine secretion specific to HIV antigens which comprises exposing cells of a vertebrate in vivo to the polynucleotide of Claim 3.

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11. A method of treating a patient in need of such treatment comprising administering to the patient the polynucleotide of Claim 3 in combination with an anti-HIV antiviral agent.

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12. A pharmaceutical composition comprising the polynucleotide of Claim 1.